CSA 2 0143

MANUFACTURE OF ABRASION RESISTANT COMPOSITE EXTRUSIONS

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a process for forming composite extrusions and the products formed thereby, particularly glass run channel composites. More particularly, the present invention pertains to glass run channel composite extrusions comprised of an elastomeric thermoset and either a crosslinkable thermoplastic or a crosslinkable high ethylene content EPDM.

Discussion of the Art

It is common in the motor vehicle industry to fashion sealing sections for various parts of an automobile by extruding such sections from certain thermosetting polymeric materials. Examples of typical sealing sections manufactured by such a process include glass run channels. These glass run channels are mounted in the window frames of automobile doors to provide a seal between the door and the glass as well as to hold the glass snugly in the window frame.

Various thermoset elastomeric materials, such as ethylene-propylene-diene terpolymer (EPDM) and styrene-butadiene copolymer rubber (SBR), have been used to form these glass run channels. These materials are favored by manufacturers because they are relatively inexpensive compared

to thermoplastics and generally exhibit the desired flexibility necessary for providing an effective seal and acceptable weatherability properties. However, these elastomers typically lack the low-friction, abrasion resistance that is necessary at the point of contact with the window glass for extended life of the channel.

Manufacturers have therefore attempted a variety of approaches to improve the wear resistance of elastomeric sealing sections. One such strategy used in the manufacture of glass run channels has been to apply a coating of low friction polymer to the surface of the elastomeric glass run channel along the area that contacts the glass. These coatings are usually applied directly to the channel surface as a solvent-based spray or after an application of a primer or adhesive layer to the elastomer. However, this method is not completely satisfactory. In addition to longer processing time and added material cost, it is difficult to obtain a satisfactory bond between the elastomer and the surface coating. Sprayed on coatings are prone to cracking while an adhered layer is susceptible to peeling.

Another method that manufacturers have used to improve the wear resistance of extruded glass run channels is to cohesively bond a layer of wear resistant thermoplastic to the elastomeric portion of the glass run channel. Several techniques have been developed to accomplish this. According to one method, the elastomer rubber and the thermoset are co-extruded. The laminate is then passed through an oven in which the elastomer rubber is cured and the interface between the thermoset and the rubber is heated to such a degree that the thermoset partially melts, causing it to adhesively bond with the rubber. Alternately, the rubber is extruded first

and passes through an oven in which it is partially cured. A preheated thermoplastic is then extruded onto the vulcanized rubber. The residual heat of the rubber melts the thermoplastic at the interface between the two, forming a bond between the two materials.

One thermoplastic that is often used in this process is ultra high molecular weight polyethylene (UHMWPE) due to its superior abrasion resistance and good affinity with EPDM. Commonly, the UHMWPE is purchased in tape form and applied onto the elastomer rubber part. Although this tape provides satisfactory results, it is relatively expensive and increases the cost of production. In addition, due to its ultra high molecular weight, the tape does not effectively melt when splicing the joints of the ends of different spools together. This difficulty in joining two tape spools together in line causes production inefficiency and waste.

Thus, there is a need for a new method for producing glass run channel composites that overcomes the deficiencies and limitations of the prior art.

BRIEF SUMMARY OF THE INVENTION

The present invention provides a process for forming an extruded glass run channel comprising a main body member of elastomeric rubber and an abrasion resistant layer, the abrasion resistant layer comprising a crosslinkable polyolefin or crosslinkable high ethylene content EPDM. In one embodiment, the elastomeric rubber is EPDM and the crosslinkable polyolefin is a moisture curable polyethylene. The crosslinkable polyethylene may contain grafted silane functional groups. In the presence of moisture, water

hydrolyzes the silane. Under the action of a catalyst, the resulting silanol groups then condense to form intermolecular crosslinking sites. Alternately, crosslinkable high ethylene content EPDM may be used as the abrasion resistant layer. Preferably, the high ethylene content EPDM contains from about 70 to about 95 weight percent ethylene and from about 3 to about 11 weight percent ethylidene norbornene (ENB) and has a crystallinity of from about 8% to about 36%. The EPDM may be cured by sulfur or peroxide agents. The crosslinkable polyolefin or the crosslinkable high ethylene content EPDM can be applied to the elastomer rubber main body member by extruding the material directly onto the rubber or by extruding the material into a tape form and applying the tape to the EPDM by means of a laminating technique.

The crosslinkable polyolefin layer provides all the advantages of UHMWPE tape, including comparable toughness, without the high cost and splicing difficulties typically associated with such tape. The versatility of such material allows it to be applied to the elastomer rubber member in several ways. In a first preferred technique, the crosslinkable polyethylene is co-extruded with an uncured EPDM main body member and then exposed to water to crosslink the polyethylene. In a second technique, the crosslinkable polyethylene is extruded into a tape form and crosslinked by immersion in a water bath, or otherwise exposed to water. Subsequently, the tape is then laminated to an uncured EPDM main body member via a lamination die. The resulting composite is then passed through an oven to cure the EPDM. In a third technique, the crosslinkable polyethylene is extruded onto a cured or partially cured EPDM main body member. The resulting composite is then

passed through a water bath, or otherwise exposed to water, to crosslink the polyethylene. In a fourth preferred technique, the crosslinkable polyethylene is extruded into a tape form and laminated onto a cured or partially cured EPDM member. The resulting composite is then immersed in a water bath, or otherwise exposed to water, to crosslink the polyethylene.

While all the techniques produce acceptable results, if the polyethylene is applied to the EPDM prior to the curing of the EPDM, the polyethylene should be crosslinked before the EPDM may be cured. This is to ensure that the polyethylene does not melt excessively during the heating. In the first two above noted techniques, the crosslinkable polyethylene may be replaced with the noted crosslinkable high ethylene content EPDM material with similar results.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a cross section of a preferred embodiment glass run channel for an automobile in accordance with the present invention.

Figure 2 is a preferred cross section of another embodiment glass run channel for an automobile in accordance with the present invention.

Figure 3 is a depiction of a first preferred technique of the present invention for manufacturing a composite extrusion suitable for use as glass run channel for an automobile.

Figure 4 is a depiction of an alternative preferred technique of the present invention for manufacturing a composite extrusion suitable for use as a glass run channel for an automobile.

Figure 5 is a depiction of an another alternative preferred technique of the present invention for manufacturing a composite extrusion suitable for use as a glass run channel for an automobile.

Figure 6 is a depiction of yet another alternative preferred technique of the present invention for manufacturing a composite extrusion suitable for use as a glass run channel for an automobile.

Figure 7 is a flowchart depicting the main processing steps in the first preferred technique of the invention detailed in figure 3.

Figure 8 is a flowchart depicting the main processing steps in the second preferred technique of the invention detailed in figure 4.

Figure 9 is a flowchart depicting the main processing steps in the third preferred technique of the invention detailed in figure 5.

Figure 10 is a flowchart depicting the main processing steps in the fourth preferred technique of the invention detailed in figure 6.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The present invention provides a variety of sealing strips and glass run channels. Briefly, the glass run channels preferably comprise at least two components, each formed from particular materials and having a unique cross-sectional configuration. A preferred glass run channel comprises a thermoset elastomer rubber main body member having a bottom wall and two transversely extending side walls. Disposed at the distal ends of the pair of side walls, opposite from the bottom wall, are a pair of sealing lips. Together, the bottom wall, side walls, and sealing lips define an interior chamber that receives and retains an edge or portion of a glass window.

The glass run channel also comprises a layer of an abrasion resistant material disposed on the top surface of the bottom wall. The layer is exposed to and faces the interior chamber. As explained in greater detail below, the layer preferably comprises a moisture crosslinkable polyolefin or a high ethylene content EPDM rubber.

With reference to figures 1 and 2, cross-sections of two preferred embodiment glass run channels for an automobile in accordance with the present invention are shown. The preferred glass run channels are comprised of a main body member **2,** made from one or more of a number of elastomeric thermoset rubbers known in the art to be suitable for glass run channel applications, and an abrasion resistant layer **4**. Examples of suitable elastomeric thermoset rubbers for use in forming the main body member **2**, include, but are not limited to, ethylene-propylene-diene terpolymer (EPDM) rubber, styrene butadiene copolymer rubber, acrylonitrile-butadiene rubber, and natural or synthetic isoprene rubber. A preferred elastomer is EPDM. The elastomer can include a range of additives known in the art such as calcium carbonate, carbon black, clay, and silica in any concentration that does not adversely affect the properties of the elastomer.

In one preferred embodiment (figure 1), the main body member **2** is formed having a bottom wall **106** joined on either longitudinal side to a transverse side wall **108**. The bottom wall has a top and bottom surface (not numbered). Attached to the distal end of the side walls and projecting inward therefrom are generally symmetrical sealing lips **110** to engage and seal against a car window (not shown). Together, the bottom wall **106**, side walls **108**, and sealing lips **110** define an interior chamber **120** that receives and

retains an edge or portion of a glass window (not shown). Projecting outward from either side wall **108** are one or more relatively short upwardly directed retention spurs **112** and generally longer downwardly directed retention spurs **114** which function to hold the glass run channel securely in the vehicle door frame and sash (not shown). Preferably, the upwardly directed retention spurs **112** are located adjacent the bottom wall **106**. The downwardly directed retention spurs **114** generally project substantially parallel to the side walls **108**.

In a second preferred embodiment (figure 2), the main body member **2** is formed having a bottom wall **206** joined on either longitudinal side to a pair of substantially vertical side walls, 2**08** and **218**. The bottom wall has a top and bottom surface (not numbered). A first side wall **208** is substantially straight and of uniform thickness from its base to its top (not numbered). Attached to the upper end of the first side wall **208** and projecting inward and slightly downward therefrom is a sealing lip **210** to engage and seal against a car window (not shown). The second side wall **218** has a protruding area **220** adjacent to the tip **222** of the sealing lip **210** that, along with the sealing lip, assists in securely holding a window (not shown). Projecting upward and inward from a second side wall **218** is a second sealing lip **224** that provides an additional point of contact to snugly hold the window. Together, the bottom wall **206**, side walls **208** and **218**, and sealing lips **210** and **224** define an interior chamber **220** that receives and retains an edge or portion of a glass window (not shown). Projecting outward from either side wall, **208** and **218**, are one or more relatively short upwardly directed retention spurs **212** that function to hold the glass run channel securely in the vehicle door frame and

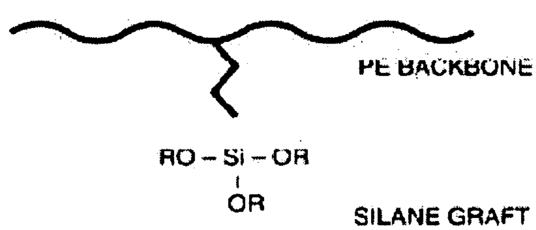
sash (not shown). Also projecting outward from each side wall, **208** and **218**, is a downwardly directed retention spur **214**. These retention spurs **214** preferably extend generally downward toward the bottom wall **206**. Two different embodiments of the invention have been described. Depending on the make of the automobile and the shape of the window and door frame, many alternative embodiments are also contemplated.

Irrespective of the exact shape of the main body member, extruded onto the upwardly directed top surface (not numbered) of the bottom wall, **106** in figure 1 and **206** in figure 2, of the main body member **2** is the abrasion resistant layer **4** comprised of a crosslinkable thermoplastic or a crosslinkable high ethylene content EPDM. This abrasion resistant layer **4** is applied along the glass run channel at those areas that contact the glass (not shown) to improve the wear resistance of the glass run channel at those locations. In addition, the abrasion resistant layer **4** may be extruded onto other areas of the main body member **2** that contact the glass window for added protection and scuff resistance, such as the top surfaces (not numbered) of the various sealing lips, **110**, **210** and **224**.

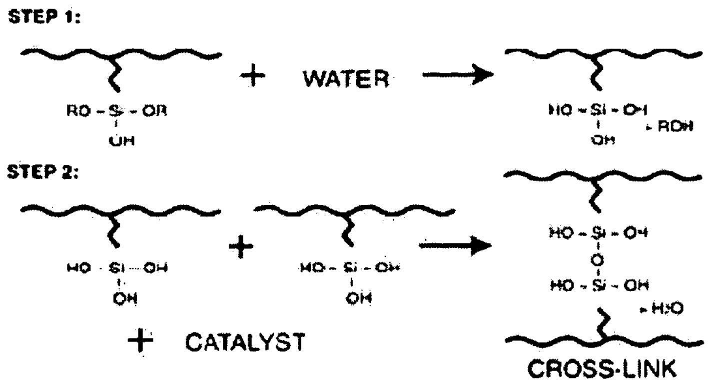
As explained in greater detail herein, in the final composite extrusion, such as incorporated into a door or window assembly, the abrasion resistant layer comprising at least one crosslinkable thermoplastic or a crosslinkable high ethylene content EPDM, is at least partially crosslinked. Thus, although much of the description herein refers to the abrasion resistant layer as comprising a crosslinkable material (as noted above), it will be understood that in its preferred final manufactured form, the composite extrusion of the

present invention utilizes an abrasion resistant layer that comprises an at least partially crosslinked material.

In a particular embodiment of the invention, the abrasion resistant layer **4** is comprised of a crosslinkable thermoplastic. A preferred thermoplastic is a moisture crosslinkable polyolefin. A particularly desirable composition is a crosslinkable high density polyethylene that can be crosslinked by electron beam radiation or by a one or two-stage silane crosslinking process. Electron beam radiation crosslinking is not preferred because of its expense. However, it is contemplated that the present invention composite extrusion and related methods could utilize such a technique for crosslinking. One stage silane crosslinking involves the extrusion of a direct mixture of polyethylene resin with a silane concentrate that includes a catalyst. The extrudate is subsequently crosslinked in the presence of water. In two stage crosslinking, silane is first grafted to the polyethylene molecular chains according to known reactions to yield silane grafted polyethylene.



Subsequently, the silane-grafted polyethylene is mixed with a silanol condensation catalyst and then exposed to water to effect crosslinking of the silane grafted polyethylene in a two step reaction. First, the water hydrolyzes the silane to produce a silanol. The silanol then condenses to form intermolecular, irreversible Si-O-Si crosslink sites.



The amount of crosslinked silane groups, and thus the final polymer properties, can be regulated by controlling the production process, including the amount of catalyst used. A gel test (ASTM D2765) is used to determine the amount of crosslinking. Prior to being silane grafted, the polyethylene may have a melt flow index similar to other extrusion grades of polyethylene, for example 1.5 g/10 min as per ASTM D1238. After being silane grafted, however, the melt flow index is dramatically reduced, for example to 0.2 g/10 min. The catalyst can be any of a wide variety of materials that are known to function as silanol condensation catalysts including many metal carboxylates and fatty acids. Both a silane grafted base resin and catalyst suitable for the present application are available from AT Plastics Corp., Brampton, Ontario, under the trade names Flexet® 5100 for the base resin and Flexet® 725 for the catalyst.

Alternately, a crosslinkable high ethylene content EPDM can be used as the abrasion resistant layer **4**. The EPDM preferably contains from about 70 to about 95 weight percent ethylene and from about 3 to about 11 weight percent diene. The preferred diene is ethylidene norbornene. Preferably, the EPDM exhibits a crystallinity content of from about 8% to about 36%. A high ethylene content EPDM suitable for use in the preferred embodiment glass

run channels is available from DuPont Dow Elastomers LLC, under the trade names Nordel® IP 4920, 4770 and 4720.

Regardless of which of the two above mentioned materials is used as the abrasion resistant layer **4** for the glass run channel, it can be applied to the main body member **2** in one of several different ways. For ease of description, the different processes will be described utilizing a two stage crosslinkable, silane-grafted polyethylene as the abrasion resistant layer **4** and EPDM as the thermoset elastomer rubber main body member **2**. However, the present invention includes the use of other crosslinkable polyolefins as well as a high ethylene content EPDM as the abrasion resistant layer **4.** Additionally, the present invention includes the use of an array of other thermoset elastomers besides those described above.

Referring to figure 3, the present invention also provides a first preferred technique for producing a composite extrusion by co-extruding an uncured EPDM main body member **2** and an uncrosslinked polyethylene abrasion resistant layer **4** through a common extrusion die. With reference to figure 7, a schematic diagram is shown outlining the processing steps in this first preferred technique. Briefly, an EPDM rubber and crosslinkable polyethylene are provided **350**, **352**. The EPDM rubber and the crosslinkable polyethylene are coextruded **354** to form a main body member **2** and an abrasion resistant layer **4**, respectively. Subsequently, the crosslinkable polyethylene of the abrasion resistant layer is at least partially crosslinked **356**. The EPDM rubber of the main body member is then at least partially cured **358** prior to removal of the assembly from the processing line **360**.

With greater detail and with further reference to figure 3, a first extruder **10** for a silane-grafted crosslinkable polyethylene and a second extruder **12** for EPDM are placed in communication with a common extrusion die **14**. To allow the EPDM compound to flow sufficiently to be extruded, the EPDM extruder **12** is preferably maintained at a temperature of from about 70°C to about 85°C. For the same reason, the polyethylene extruder **10** is preferably maintained at about 160°C to about 200°C. The extrusion die **14** is preferably maintained at about 110°C on the EPDM side **16** and from about 200°C to about 220°C on the polyethylene side **18**. Insulation (not shown) between the two sides of the extrusion die allows for this disparity in temperatures to be achieved. The EPDM and polyethylene are extruded at a pressure of from about 2000 to about 3000 psi. The polyethylene and EPDM are co-extruded such that the polyethylene mechanically bonds with the EPDM by partial melting and diffusion therewith. The thickness of the resulting polyethylene layer is from about 0.005 to about 0.040 inches, preferably from about 0.010 to about 0.020 inches and typically about 0.020 inches.

A resulting composite extrusion **20** comprising the extruded EPDM and polyethylene is then passed through a steam bath **22** to effect crosslinking of the polyethylene. The steam bath **22** is preferably at a temperature of from about 100°C to about 110°C. To cure the EPDM, the composite extrusion **20** is then passed through an oven **24** at a temperature of from about 195°C to about 300°C, depending on the grade of EPDM used in the main body member **2**. Preferably, the total oven cure time is between about 1.3 and about 4 minutes. In a particularly preferred embodiment, the composite extrusion **20** is passed through a number of temperature zones in the oven **24**

starting at about 195°C for about 15 to about 50 seconds, ramping up to about 220°C for about 45 seconds to about 2.4 minutes and then ramping down to about 195°C for about 15 to about 50 seconds, prior to exiting the oven. The composite extrusion is then cooled in a water or air cooling tank **26** to about 30°C to 60°C before removing it from the manufacturing line.

In a second preferred technique in accordance with the present invention and illustrated in figure 4, the polyethylene is extruded into a tape and crosslinked prior to laminating it onto an uncured EPDM main body member. As used herein, the word "tape" and the words "tape member" are both used to designate a thin laminar structure having a generally uniform thickness. Preferably, the tape does not include the use of a separate adhesive to bond it to the main body member, although such use is contemplated and within the scope of the invention.

With reference to figure 8, a schematic diagram is shown outlining the processing steps in this second preferred technique. Briefly, an EPDM rubber and crosslinkable polyethylene are provided **450**, **452**. The EPDM rubber is extruded **454** into a main body member and the crosslinkable polyethylene is extruded **456** into an abrasion resistant tape layer. The abrasion resistant tape layer is at least partially crosslinked **458** and then cooled **460**. The abrasion resistant tape layer is then laminated **462** onto the main body member. The main body member is subsequently cooled **464** prior to the assembly being removed **466** from the processing line.

With additional detail and with further reference to figure 4, the polyethylene is extruded from a polyethylene extruder **30** through a first die **32** into an uncured tape **34** and subsequently crosslinked in a steam bath **36**.

The at least partially crosslinked tape **38** is then cooled in a water cooling tank **40**. The at least partially crosslinked tape **38** may be gathered at an accumulator **42** and is then subsequently laminated via a lamination die **44** onto a main body member made from uncured EPDM rubber extruded through the lamination die **44** from a rubber extruder **46**. The rest of the process is similar to that described for the first embodiment, with the formed EPDM/polyethylene composite extrusion **48** passing through an oven **50** to cure the EPDM of the main body member and subsequently cooled down in a cool-down chamber **52** prior to removal from the manufacturing line **54**. The temperatures and pressures for the second embodiment are preferably similar to those used for the first technique in all respects except that the lamination die **44** temperature is preferably at a temperature of from about 100°C to about 120°C and the cured polyethylene tape **38**, just prior to lamination, is at a temperature of from about 30°C to about 40°C.

In a third preferred technique in accordance with the present invention, illustrated in figure 5, uncured polyethylene is extruded onto the main body member after the EPDM has been cured in the oven. With reference to figure 9, a schematic diagram is shown outlining the processing steps in this third preferred technique. Briefly, an EPDM rubber and crosslinkable polyethylene are provided **550**, **552**. The EPDM rubber is extruded **554** into a main body member and the main body member is subsequently at least partially cured **556**. The crosslinkable polyethylene is extruded **558** as an abrasion resistant layer onto the main body member. The abrasion resistant layer is crosslinked **560** and cooled **562** prior to removal of the assembly from the processing line.

With additional detail and with further reference to figure 5, EPDM is extruded from a rubber extruder **60** through a first die **62** to form a main body member **2**. The main body member **2** is then passed through an oven **64** to cure the EPDM. Upon emerging from the oven **64**, an abrasion resistant layer comprising polyethylene is extruded through a second die **66** that is fed by a polyethylene extruder **68** onto the cured main body member **2** to form a composite extrusion **70**. The composite extrusion **70** is passed through a steam bath **72** to crosslink the polyethylene and then passed through a cooling chamber **74** prior to take off from the manufacturing line. The temperatures and pressures for the third technique are preferably similar to those used for the first technique in all respects except that the first die **62** is at a temperature from about 100°C to about 120°C and the second die **66** is at a temperature from about 200°C to about 220°C.

In a fourth technique, shown in figure 6, uncured polyethylene is extruded into a tape and then laminated onto a cured EPDM main body member. With reference to figure 10, a schematic diagram is shown outlining the processing steps in this fourth preferred technique. Briefly, a thermoset elastomer rubber and crosslinkable thermoplastic are provided **650**, **652**. The EPDM rubber is extruded **654** into a main body member and the crosslinkable polyethylene is extruded **656** into an abrasion resistant tape layer. The main body member is at least partially cured **658** and the abrasion resistant layer then laminated **660** onto the main body member. The abrasion resistant tape layer is then at least partially crosslinked **662** before the resultant assembly is cooled and removed **664** from the processing line.

With additional detail and with further reference to figure 6, EPDM from a rubber extruder **80** is extruded through a first die **82** into a main body member **2**. The main body member **2** is passed through an oven **84** to cure it. Polyethylene is extruded from a second extruder **86** through a second die **88** to form an uncured abrasion resistant tape **90**. A lamination wheel **92** then bonds the uncured polyethylene tape **90** to the main body member **2** to form a composite extrusion **94**. The composite extrusion **94** is then passed through a steam bath **96** to crosslink the polyethylene tape **90** and then passed through a cooling chamber **98** prior to removal from the line. The temperatures and pressures for the fourth technique are preferably similar to those used for the first technique in all respects except that the first die **82** temperature is from about 100°C to about 120°C, the second die **88** temperature is from about 200°C to about 220°C and the tape **90** temperature just prior to lamination is from about 80°C to about 130°C.

While various changes and adaptations may be made to the above methods without departing from the scope of the invention, it is important to note that, with regard to the first two techniques described, the polyethylene is most preferably crosslinked prior to passing the composite extrusion through the oven to avoid excessive melting of the uncrosslinked polyethylene. As noted herein, a crosslinkable high ethylene content EPDM may used in place of the crosslinkable polyolefin as the abrasion resistant layer in the first two techniques described. If a crosslinkable high ethylene content EPDM is used to form the abrasion resistant layer then the steam bath previously described to crosslink the polyethylene in figures 3 and 4 is replaced with a reaction

chamber (not shown) where the EPDM is crosslinked using sulfur or peroxide curing agents.

The invention has been described with reference to various preferred embodiments. Modifications and alterations will occur to others upon a reading and understanding of the specification. The invention is intended to include all such modifications and alterations insofar as they come within the scope of the appended claims and the equivalents thereof. Thus, for example, composite extrusions for other weather seal profiles in addition to automobile glass run channels can be manufactured by the techniques of the present invention. In addition, the abrasion resistant layer may be colored to match surrounding parts.